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Managing science-policy interfaces for impact: Interactions within the environmental governance meshwork

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ABSTRACT

Science-policy interface organizations and initiatives (SPIORG) are a key component of environmental governance designed to make links between science and society. However, the sciencepolicy interface literature lacks a structured approach to explaining the impacts of context on and by these initiatives. To better understand these impacts on and interactions with governance, this paper uses the concept of the governance 'meshwork' to explore how dynamic processes – encompassing prior, current and anticipated interactions – coproduce knowledge and impact via processes, negotiation and networking activities at multiple governance levels. To illustrate the interactions between SPIORGs and governance meshwork we use five cases representing archetypal SPIORGs. These cases demonstrate how all initiatives and organizations link to their contexts in complex and unique ways, yet also identifies ten important aspects that connect the governance meshwork to SPIORGs. These aspects of the meshwork, together with the typology of organizations, provide a comprehensive framework that can help make sense how the SPIORGs are embedded in the surrounding governance contexts. We highlight that SPIORGs must purposively consider and engage with their contexts to increase their potential impact on knowledge co-production and policy making.

1. Introduction

Environmental problems, including climate change, loss of biodiversity and unsustainable use of ecosystem services, require urgent policy measures to mitigate negative impacts and adapt to change. Science can help address such 'wicked' problems (Rittel & Webber, 1973; Sharman and Mlambo, 2012): by increasing understanding of the problems; by supporting policy; by promoting learning; and by considering new action to develop socially acceptable and environmentally friendly solutions. To realize this promise, various organizations and initiatives – hereafter abbreviated as Science-Policy Interface Organizations (SPIORGs) – have been set up to improve the relationships between science, policy, markets and civil society. These interlinked domains form a governance context that is impacting on and impacted by SPIORGs. Existing SPIORGs range from relatively small-scale, narrowly-focused initiatives to broad-reaching institutions acting on a global scale. Simultaneously, there has been extensive research and debate regarding how best to design and operate these SPIORGs such that they contribute effectively to alleviating environmental problems (Turnhout et al., 2016; Young et al., 2014; Nesshöver et al., 2016).

Science-policy interfaces can be understood as social processes (van den Hove, 2007), or as all the ties where science and other governance contexts (e.g. policy, markets and society) intersect (McConney et al., 2016). The SPIORG concept refers more narrowly to those initiatives purposively set up to support interaction processes facilitating connectivity between science and other governance contexts in order to alleviate environmental problems. Their role is well described by the concept of 'boundary organizations' as integrative nodes between

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governance contexts where relationships between various actors can be built and re-negotiated (Star and Griesemer, 1989; Guston, 2001). While the internal design features or characteristics of SPIORGs (e.g. Sarkki et al., 2015) and boundary interactions among SPIORG participants (Leith et al., 2016) have been examined, structured accounts of interactions between SPIORGs and their governance contexts are more scarce, despite their importance (e.g. McConney et al., 2016; Chilvers and Evans, 2009).

SPIORGs are linked to their governance contexts via multi-directional co-production processes, which shape SPIORGs, their knowledge outputs and impacts on decision making (e.g., Gibbons et al., 1994; Lemos and Morehouse, 2005; Lövbrand, 2011). SPIORGs can impact on governance processes and decisions through knowledge inputs, interaction processes, and by introducing new ways to structure interactions between various actors (Tinch et al., 2018). Furthermore, the changes in governance decisions influence on people's behavior in a larger socio-cultural context, which in turn is linked to the environmental context (MA, 2005). This view on multilayered contexts helps to understand potential impacts SPIORGs can have as illustrated by the following examples.

Even though tackling environmental problems may be the ultimate target of SPIORGs, their direct environmental impacts are difficult to verify as they often result from complex long term interactions. More proximate influences are easier to detect. For example, since the early 1990s the UN's Convention on Biological Diversity's (CBD) Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) has produced a total of 193 recommendations to the Conference of the Parties of CBD, some of which have been endorsed in full (CBD, 2016). Therefore, the advice by SBSTTA as an SPIORG has been transferred to policy agendas, for example informing the Aichi 2020 biodiversity targets. The monitoring of progress to the 2020 targets is achieved largely by indicators that are supplied by science and updated by SBSTTA. Furthermore, CBD's National Biodiversity Strategies and Action Plans (NBSAP) are a key policy tool for implementing the 2020 targets and have been developed by 189 countries. However, despite these processes, biodiversity loss and unbalanced use of ecosystem services has not been halted. The effects that most evident are often conceptual, and these may precede other actions (Waylen and Young, 2014). For example, it is hard to pinpoint the direct environmental impact of the Millennium Ecosystem Assessment (MA, 2005) global assessment process but it has certainly contributed to mainstreaming ecosystem service thinking into environmental knowledge production and policy-making, and has supported use of economic valuation and economic instruments in environmental governance (Dempsey and Robertson, 2012; Gómez-Baggethun and Ruiz-Pérez, 2011).

These examples illustrate that multiple impacts need to be considered, and also that the impacts need to be comprehended as being co-produced by SPIORGs and other governance actors. For example, the knowledge on biodiversity loss has co-evolved with high level global and European policy objectives to halt biodiversity loss and leading also to the introduction of a new logic to view environmental conservation via the concept of ecosystem services. Thus, when aiming to assess impacts by SPIORGs they need to be viewed as part of complex governance contexts, rather than as isolated organizations, events or processes. The networked nature of environmental governance makes it especially important to understand the governance context in which SPIORGs are embedded, and which SPIORGs may in turn influence (Newig et al., 2010; Tinch et al., 2018). It is very difficult to assess the ultimate environmental impacts of particular SPIORGs, so in this paper we instead focus on pathways to impact that are co-produced by SPIORGs and governance contexts (see Weichselgartner and Kasperson, 2010).

We consider that the boundaries between SPIORGs and their governance contexts are blurred (Turnhout et al., 2013) and more detailed understanding on what happens across this boundary is an important topic for the literature on science-policy interfaces. This "boundary problem" has already been highlighted by Gieryn (1995: 393) who asks *"where does science leave off and society begin?"*. However, instead of defining sharp boundaries between SPIORGs and governance contexts it is crucial to understand how they intermingle to co-produce impacts. The relevance of governance contexts to SPIORGs impacts has been demonstrated: there is no best practice in SPIORG design, but solutions must be tailored to their specific policy contexts (Sarkki et al., 2014); credibility, relevance and legitimacy are co-defined by a boundary organization's internal design features and its external governance and social contexts where the SPIORG participants and target groups are connected (Cash et al., 2003; White et al., 2010); and contextual factors (e.g. actors' objectives and agendas, policies, availability of social and technical solutions) co-determine SPIORGs' influence with internal design features (Weichselgartner and Kasperson, 2010).

To clarify, define and account for the relevant aspects of governance context we propose that SPIORGs should be examined as an integral part of "governance meshwork" (see Ingold 2008 a, b). The environmental governance meshwork consists of actors, organizational structures, regulations, mandates, and knowledge at multiple levels (see Section 2). To illustrate the detail and complexity of the diverse SPIORGs within the environmental governance meshwork, we employ a typology of SPIORGs to select five types of SPIORGs. This typology (Timaeus et al., 2013) and case studies (Tinch et al., 2018) have been published previously. Here we synthesize and build on these, together with other findings arising from the SPIRAL EU FP 7 project (Nesshöver et al., 2013; SPIRAL team, 2012; Timaeus et al., 2013; Young et al., 2013a, 2013b, 2014; Sarkki et al., 2014, 2015, 2016; Tinch et al., 2018; Waylen and Young, 2014) to meet our objectives.

The overall objective of this paper is to explore how SPIORGs impact and are impacted by governance contexts. We achieve this by 1) providing a novel framing of SPIORGs as existing within, influencing, and continuously evolving in a "governance meshwork", 2) describing cases to illustrate how the framing may be applied and 3) identifying and categorizing relevant aspects of governance meshwork linked to environmental SPIORGs in different ways. We conclude by discussing how this perspective allows us to better understand the various pathways to impacts of SPIORGs. Examining SPIORGs as parts of governance meshwork also allows us to examine how SPIORGs and governance meshwork evolve together, affecting each other as a result of complex interactions (Cornell et al., 2013; Beck et al., 2014).

We start by outlining the governance meshwork approach and its implications for examining SPIORGs. We then present material and methods for synthetizing SPIRAL results on five illustrative examples representing divergent types of SPIORGs. By exploring different types of SPIORGs, we illustrate how diverse aspects of governance meshwork have various implications for SPIORGs across the employed typology. Based on the case studies, we identify ten aspects of governance meshwork, and discuss the connecting factors between SPIORGs and aspects of governance meshwork that help to explain the impacts of SPIORGs.

2. Meshwork approach

The complexity of governance contexts in which the SPIORGs operate suggests the concept of governance meshwork can be helpful. Meshwork implies active and ongoing interplay between SPIORGs and other organizations and actors (see Ingold, 2008b). Ingold (2008a) proposes an 'open view' of meshworks where boundaries between component parts are not sharp, but characterized by continuous change; this aspect is also increasingly discussed in the context of SPIORGs (Cornell et al., 2013; Beck et al., 2014). The dynamics of a governance meshwork both enables and restricts the functioning of the SPIORGs, for example by providing access to resources, knowledge, and actors, or by limiting the impact of SPIORGs resulting from lack of connections to policy makers or other stakeholders who may implement the decisions supported by the work of SPIORGs. Furthermore,

organizations and individuals can learn to navigate within a specific governance meshwork, increasing their agency within a complex set of governance contexts (Ingold, 2008b).

The meshwork approach diverges from the more common notion of networks. The network approach considers that the relationships between the nodes in the network are rather more important than the characteristics of the nodes themselves in explaining interactions within the network (Chilvers and Evans, 2009). However, the meshwork approach considers that both the relationships and the characteristics of the nodes are equally important. Furthermore, a meshwork is not merely a network of organizations in a multi-level setting (Andonova and Mitchell, 2010), nor a knowledge network (Nesshöver et al., 2016). A meshwork approach takes into account that actors related to SPIORGs can be not only people and organizations, but also "non-human actors" (Latour, 2005), such as policy mandates, agreements, knowledge or environmental non-human entities themselves.

The governance meshwork approach builds on the idea of boundary organizations (Star and Griesemer, 1989; Gieryn, 1995; Guston, 2001) by realizing that firstly, SPIORGs do not just connect realms of science and policy, but also link to various other types of actors and agreements in the governance meshwork. This provides a more detailed definition of the heterogeneous types of governance contexts where SPIORGs are embedded. Secondly, SPIORGs cannot initiate participation and accountability for each side of the boundary from an empty slate, but actors who are involved in SPIORGs carry the assumptions, values, concerns and paradigms of their home organizations, dependencies and linkages that co-determine or even dominate the negotiations at the SPIORGs (Sarkki et al., 2016).

The meshwork approach has commonalities and differences also with the concept of ethno-epistemic assemblages, which has been developed to blur the boundaries between different kinds of governance actors (e.g. scientists, experts, policy makers, businesses, NGOs, citizens) and to focus on how these diverging actors find a common purpose or agenda and form assemblages to drive certain agendas (Irwin and Michael, 2003; Allgaier, 2012; Carmen et al., 2016). The meshwork approach acknowledges divergent governance actors and recognizes that impact within governance meshwork can take place due to an assemblage driving a common agenda, but it concentrates more strongly on individual nodes and relationships between the nodes that evolve through time. The difference is like comparing a soccer game with teams (ethno-epistemic assemblages) to a nightclub with divergent actors having divergent and dynamic characteristics, identities, histories and relationships with each other (governance meshwork).

The meshwork concept has not often been used to examine environmental governance. Recently Schwartz et al. (2015) have used the meshwork concept to demonstrate that the distinction between formal and informal modes of governance does not reflect a reality in which informal and small scale governance forms also include infrastructures, financing and regulatory institutions. Governance actors are not, according to this view, distinguished according to their type (i.e. scientists; policy maker; stakeholders), but *"embody multiple identities and use these identities in various sites of governance in order to"* make an impact on governance decisions (Schwartz et al., 2015: 31). Our interpretation of the "multiple identities" is that the movement of actors within governance meshwork results in simultaneous and diverse organizational identities. However, our approach goes beyond the notion of multiple identities by identifying a range of different types of concrete governance contexts where the multiple identities are nested. We believe that this typology of contexts is useful to analyze how SPIORGs make impact to the rest of the governance meshwork.

Applying the concept of meshwork to SPIORGs offers several advantages. Firstly, considering the relationships between nodes acknowledges that any SPIORG is a node in a meshwork connected by multi-directional interaction processes with other nodes, including initiatives and organizations at various governance levels. These may be organizations providing resources (e.g. funding, mandate, knowledge) for SPIORGs, or actors who are "clients" receiving knowledge and policy support from SPIORGs. Secondly, it assumes that policy makers and other stakeholders who participate in the processes linked to SPIORGs and within SPIORGs do not enter into interaction processes as "neutral" actors, but have various pre-existing characteristics (e.g. positions in other organisations and SPIORGs; knowledge systems) that influence the interactions within and beyond SPIORGs. Finally, SPIORGs relate to the governance meshwork not only through knowledge exchange, but through the temporally dynamic actions, engagement, negotiation, positions and resistance of organizations and individuals (see Ingold, 2008b) thereby offering an insight into how impact is co-produced in a process of continuous interactions.

3. Material and methods

The empirical materials synthetized here were collected by the authors within the SPIRAL (Science-Policy Interfaces for Biodiversity: Research, Action and Learning) EU FP7 project (www.spiral-project.eu). Within SPIRAL, a mapping of SPIORGs was carried to give an overview of the diversity of initiatives designed to support science-policy interactions within the governance meshwork targeting biodiversity and ecosystem services. The analysis of over 150 SPIORGs carried out during this mapping exercise resulted in the publication of a typology of generic SPIORGs (Timaeus et al., 2011, 2013). The typology of five generic SPIORG types includes: 1) expert group; 2) research project; 3) state agency or institute; 4) interest group; and, (5) policy processes integrating scientific input.

The mapping was based on information collected from SPIORG websites, policy documents, and UNEP (United Nations' Environment Program) studies. The mapping was based on organizational character rather than functional objectives of the SPIORGs. This is in line with the approach of the present paper to define SPIs as organizations. The criteria to categorize the SPIORG types related to 1) their formal mandate and organizational structure, 2) the selection process of the participants involved, and 3) their lifespan or temporal scope. These criteria are not fully independent, as for example SPIORGs' structure may be designed to include certain stakeholders. Temporal scope is an independent criteria, but also puts focus on how mandates, structures and participants in SPIORGs change over time. Also the five SPIORG types may be overlapping. For example, state organizations may facilitate policy processes open to scientific input, or expert groups may also push an agenda making themselves close to interest groups. Despite some ambiguity in the typology we argue that the criteria based on organizational features is more useful than for example attempting to categorize SPIORGs according to their objectives or functions as most SPIORGs possess several functions leading to greater ambiguity in typology. Furthermore, functional criteria may be useful for evaluating SPIORGs, but not for categorizing them. Finally, as the typology is a result of meta-level mapping, the information needed to be easily available for investigators. Therefore, detailed knowledge, for example on the scope of stakeholder participation, is more difficult to obtain than basic knowledge on SPIORG structures (Timaeus et al., 2011, 2013).

Creation of the typology led to some conclusions on hindering and contributing factors relating to SPIORGs impact. A key hindering factor was lack of SPIORGs' explicit attention to their contexts and understanding conflicts and power relations between stakeholders linked to activities of the SPIORGs (Timaeus et al., 2013). This finding on better understanding of contexts and power relations provides the motivation for the present paper to consider SPIORGs impacting and impacted by governance meshwork.

SPIRAL used real life SPIORGs to confront practice with theory and identify examples of good practices in connecting science, policy and society with a focus on lessons learned regarding impacts of SPIORGs. The objective of studying these cases was to better understand their interactions with the governance and policy context, and how these

might potentially impact environmental decision-making (Young et al., 2013a, 2013b).

The present paper synthetizes results from five cases representing different parts of the SPIORG typology described above: 1) Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) (expert group), 2) EU FP projects (Research projects), 3) INBO: the Flemish research and knowledge center for nature and its sustainable management and use (state agency or institute), 4) Society for Conservation Biology (SCB) (Interest group), and 5) NBSAPs in Finland (Policy processes open to scientific input). These cases were selected because they represent each type in our SPIORG typology and because there was enough material to analyze them in terms of their relationships to the governance meshwork in which they are embedded (Supplementary material). Even though the proposed typology could be criticized by arguing that there is variability within the categories, it provides rationale for the case study selection for this paper. That the cases represent different parts of the typology ensures that there is sufficient variation in the cases to enable a wider view on interactions between SPIORGs and governance meshwork than would be possible with case studies addressing one case or SPIORGs more similar to each other. This enhances comprehensibility and generalizability of the results. Furthermore, current biodiversity science-policy interface literature is crowded by various examinations of IPBES, while other SPIORGs examined here have received less attention even though they can have important role in shaping the governance meshwork in the environmental domain. NBSAPs have been developed in 189 countries, but their role as SPIORGs has been examined in a limited way (Sarkki et al., 2016). EU projects have impacts on European environmental policy making, and discussions on how to achieve higher impact are ongoing (Nesshöver et al., 2013). Interest groups, like SCB, struggle to push their agenda for biodiversity and ecosystem services and also consider how to form strategic alliances with IPBES to maximize impact (Pe'er et al., 2013). State agencies to enhance science-policy connections in environmental domain, like INBO, exist in most countries and have significant impact on national policy making. Therefore, this paper synthetizes work from various kinds of SPIORGs that have divergent roles to play in the overall governance meshwork in the area of biodiversity and ecosystem services.

For the purposes of this paper, first-hand analyses were not consulted, but summaries, reports and articles based on these empirical materials were synthetized (see supplementary materials). This paper builds upon first-hand analyses that have been published previously (Nesshöver et al., 2013; SPIRAL team, 2012; Timaeus et al., 2013; Young et al., 2013a, 2013b; Sarkki et al., 2016; Tinch et al., 2018). The first author used directed content analysis to analyze the above publications related to the five cases, and other authors elaborated on and verified the findings. In directed content analysis, categories or research questions are derived from theory, and empirical materials are classified into these predefined categories. The emerging categories and subcategories and their contents can be used to extend and enrich existing theory (Hsieh and Shannon, 2005). Three assumptions from the literature were combined to the presented meshwork approach to formulate three specific questions under which the materials were categorized:

1) Governance contexts co-determine impacts together with SPIORGs' internal design features(Cash et al., 2003; Weichselgartner and Kasperson, 2010). Based on this assumption, the following question was formulated "What are the relevant nodes in governance meshwork explaining the impact of SPIORGs?" The above mentioned publications were analyzed to answer this question, for example in the following way: An interviewee involved in the Global Biodiversity Assessment (GBA), MA and IPBES stated that *"the UN mandate for IPBES is extremely important for impact"* (Sarkki et al., 2014; see also Young et al., 2013a, 2013b). After identifying such statements in the empirical materials, relevant for the given question, sub-categories for the question theme were formulated. In this case "mandating organizations" were identified as a key governance node explaining SPIORGs impact.
2) Co-production of knowledge and decisions takes place via dynamic interactions between SPIORGs and other governance actors (Sarkki et al., 2015; Tinch et al., 2018). Based on this assumption the question "how do various governance nodes and SPIORGs interact and explain impact?" was formulated. Insights to answer this question were extracted from the used materials by identifying subcategories to the question theme. For example, the workshop participants on EU projects agreed that end of pipe dissemination with target groups is not enough, but continuous interactions from the beginning of the project are needed (Nesshöver et al., 2013). Based on this statement, a sub-category was identified: "early and continuous interactions with target groups".
3) Boundaries between scientists, policy makers and other governance actors are blurred within the SPIORGs as boundary organizations (Guston, 2001; Leith et al., 2016). Based on this assumption following question was formulated "What pre-existing characteristics of SPIORG participants impact on the boundary negotiations and how?" For example, the following statement from an NBSAP materials: "implementation of measures that NBSAPs propose is hindered by contradicting agendas and interests of the home organizations of the participating policy makers and interest groups" (Sarkki et al., 2016), was used to answer to the question. In this case "pre-existing interests hinder implementation" was identified as a sub-category for this question theme.

Based on further analysis of the above three steps, pathways for impact by SPIORGs were identified by asking how the identified subcategories under the three question themes could be used to enhance potential for impact, and by searching direct statements from the materials that proposed suggestions to increase potential for impact (e.g. INBO needs to balance pushing an agenda with honest brokering to maintain credibility and to gain impact) (Young et al., 2013a, 2013b). The results of the analysis of the cases are presented below. Finally, these results were summarized by clustering the sub-categories to identify 1) key nodes in governance meshwork, and 2) types of interactions between SPIORGs and the identified nodes explaining impact. The implications of the identified ten key nodes in governance meshwork for the SPIORGs' impact are then discussed against existing science-policy literature in Section 5.

4. Results: cases on five SPIORG types

4.1. Expert groups: IPBES

Expert groups are initiatives or organizations working at the intersections of science and society to produce, capitalize and communicate important knowledge to support policy making. Examples of expert groups include IPBES, The Economics of Ecosystems and Biodiversity (TEEB) initiative, AfriBES, A Biodiversity Science-Policy Interface Mechanism for Europe, and Science for EU Environment Policy Interface (SEPI). IPBES operates under the auspices of four United Nations programmes/organizations (e.g., UNEP, UNESCO). It currently has 125 member states, and promotes the sustainable use and conservation of biodiversity and the ecosystem services it provides. It mainly operates via temporary groups of nominated experts to deliver assessments and reports and provide policy support and capacity building activities (see Görg et al., 2010; Beck et al., 2014; Kovács and Pataki, 2016; Larigauderie et al., 2016). Table 1 outlines key lessons learned from IPBES.

4.2. Research projects: EU projects

Research projects with outreach objectives aim to provide and

Table 1
Illustration of key issues for expert groups: IPBES.

Case	IPBES
What are the relevant nodes in governance meshwork explaining the impact of SPIORGs?	Political mandates; Knowledge systems of IPBES participants; Selection of included political representatives (of UN regions and nation states); International conventions and agreements; Organizations and actors funding IPBES work.
How do various nodes in governance meshwork and SPIORGs interact and explain impact?	How different actors, groups and nation states are represented in IPBES and whether they perceive the work of IPBES as legitimate; Links between current IPBES activities to preceding SPIORGs in the same domain (e.g. lessons learned from Global Biodiversity Assessment and Millennium Ecosystem Assessment); Capacity building processes involving financial and in-kind support.
What pre-existing characteristics of SPIORG participants impact on the boundary negotiations and how?	The nature of expertise held by participants in IPBES: (i) The “home” disciplines of involved scientists (e.g. natural vs. social scientists); and (ii) The knowledge systems familiar to the participating policy-makers and stakeholders; The existing and previous relationships that IPBES participants have, including contradictions.
Pathways to impact	To connect effectively to policy and societal actors and groups in order to move from deliberations to impact; To represent various nations and knowledge systems in a legitimate and credible manner; To gain a widely supported political mandate; To solve contradictions and conflicts between the parties; To secure funding for operation.

Table 2
Illustration of key issues for European research projects.

Case	EU projects
What are the relevant nodes in governance meshwork explaining the impact of SPIORGs?	Policy makers with certain kind of knowledge needs; Funding organizations and scope of funding calls; “Client” organizations using the produced knowledge and tools; Involved expertise.
How do various nodes in governance meshwork and SPIORGs interact and explain impact?	Connections and interactions between research projects, policy makers and other target groups; Connections and synergies between other projects; Dissemination of results; Transdisciplinary engagement of stakeholders to knowledge production; Projects’ advisory groups and boards that provide expertise and diffuse results.
What pre-existing characteristics of SPIORG participants impact on the boundary negotiations?	Existing networks of individual researchers; Abilities to work as ambassador and facilitator; Prior fields of expertise of involved researchers; Knowledge systems and expertise of the involved scientists and other knowledge holders.
Pathways to impact	Moving away from ‘end of pipe’ dissemination to continuous and early phase communication; To establish connections to policy makers informally (by using previous networks of individual scientists) or formally (by establishing advisory and policy groups a formal part of the project consortium); To understand and contribute to the wider policy context and related challenges; To lobby certain research themes to be funded; Ability to interpret and convey key messages to policy makers and other target groups via continuous interactions.

translate scientific knowledge for the purposes of policy. Here we use the case of a set of European research projects in the field of biodiversity and ecosystem services that aimed to produce new knowledge, but also to reach out to enhance interactions between science and policy (Nesshöver et al., 2013) (Table 2).

4.3. State agencies: INBO

State agencies receive state funding and a mandate, and have linkages to various organizations and actors as requested by the state. These SPIORGs often have to have special regard to maintaining credibility and legitimacy in the eyes of many diverse actors, and may have to supply knowledge for organizations whose agendas may be in contradiction (e.g. for economy vs. nature oriented organizations). Here we use the case of the Flemish research and knowledge center for nature and its sustainable management and use – INBO (Table 3). INBO works primarily for the Flemish government, but also supplies information for international reporting and addresses issues at the level of local authorities. In addition, INBO supports organizations for nature management, forestry, agriculture, hunting and fisheries (https://www.inbo.be/en/about-inbo). Examples of other cases include NIOZ (Royal Netherlands Institute for Sea Research: http://www.nioz.nl/home_en), and the EEA (European Environmental Agency: http://www.eea.europa.eu/).

4.4. Interest groups: the society for conservation biology

Interest groups are organizations and initiatives promoting a certain agenda. The example used here is the Society for Conservation Biology (SCB) (Table 4). The web pages of the SCB define SCB as "an international professional organization dedicated to promoting the scientific study of the phenomena that affect the maintenance, loss, and restoration of biological diversity" (http://conbio.org/about-scb/who-we-are/). Conservation biology is regarded by Meine et al. (2006) as a “mission-driven discipline” which is legitimated by the need for biodiversity conservation. However, there are diverging views within the organization regarding whether and how to engage with policy and politics in an advocacy role for conservation, or rather to remain in a more informative and neutral policy support role, thus ensuring that scientific credibility is not compromised (see the discussion in Vol. 21, No. 1 in Conservation Biology with focus on policy advocacy and conservation science). Other interest groups in addition to learned

Table 3
Illustration of key issues for state agencies: INBO.

Case	INBO: the Flemish research and knowledge center for nature and its sustainable management and use.
What are the relevant nodes in governance meshwork explaining the impact of SPIORGs?	Client organizations for the SPIORG; State or other mandating and funding organization; Networks of knowledge based organizations and projects.
How do various nodes in governance meshwork and SPIORGs interact and explain impact?	Various interests, interactions, and also political power plays between the various organizations to which INBO is linked; Ongoing and previous relationships between and INBO and its various clients.
What pre-existing characteristics of SPIORG participants impact on the boundary negotiations and how?	Expertise (knowledge, methods, facilitation abilities) gained by the members that are available for the use of INBO.
Pathways to impact	Finding way to make an argument for environmental sustainability while at the same time earning the position of an honest broker, for example, by providing alternative scenarios for informing policy choices of various and even contradicting policy makers and stakeholders.

societies like SCB are NGOs like IUCN (The World Conservation Union).

4.5. Policy processes integrating scientific input: finnish NBSAPs

SPIORGs linked to specific policy processes have often been established to support implementation of certain policies, and to facilitate linkages between actors at various levels in environmental governance meshwork. Thus, by default these SPIORGs have a close, and often formal, linkage to policy makers. We examine the CBD's National Biodiversity Strategies and Action Plans (NBSAP) (Prip et al., 2010; CBD NBSAPs, 2016; UNEP, WCMC, 2016) in the case of Finland (Table 5). To date, Finland has produced three NBSAPs. During the continuous work significant advances have taken place including establishing a collaboration group with around 40 actors from various policy sectors, interest groups and NGOs, developing monitoring mechanisms by introduction of biodiversity and ecosystem service indicators, and gaining a governmental mandate for the NBSAPs (Sarkki et al., 2016). Other examples of policy processes integrating scientific input are the implementation processes of the EU Water Framework Directive.

4.6. Summary of the results

The cases presented above highlight that SPIORGs link to governance meshwork in diverse ways. Table 6 summarizes and categorizes cases to identify key nodes of governance meshwork and their connections to SPIORGs. Each of the identified node is discussed in the Section 5.

5. Discussion

5.1. Mandating organizations

Some type of SPIORGs, especially expert groups and SPIORGs connected to specific policy process, are more likely to produce impacts if they are mandated by respected organizations or directly supported by policy makers (see Lentsch and Weingart, 2011). A mandate can be actively sought, but more often than not a mandate in a certain domain drives the establishment of a SPIORG: e.g. NBSAPs mandated by the CBD, and IPBES mandated by the UN. In relation to research projects, mandates are seldom explicitly discussed as the funding and client organizations are more relevant. Interest groups are mandated by the societal groups supporting them and can justify their agenda and mission by the public or other wider concern on the topic they are addressing. State organizations, by their nature, have state mandate thereby decreasing the need for and importance of additional mandates. The mandate can be renewed in iterative daily practices and agreed negotiation procedures (see Sarkki et al., 2015; Podestá et al., 2013). Furthermore, mandates to support certain policy agendas can move from one organization to another in the environmental governance meshwork. For example, Finnish NBSAP processes are mandated by the national government of Finland largely due to the fact that the CBD and EU have mandated the 2020 biodiversity objectives.

5.2. Funding organizations

SPIORGs need resources for their work, so organizations that can provide or enable access to resources are a key part the governance meshwork for most SPIORGs. Funding aspects link to research projects and their interfacing (the EU projects), and to SPIORGs that gain funding targeted for interfacing including INBO and IPBES. While many biodiversity and ecosystem service related expert groups and state

Table 4
Illustration of key issues for interest groups: Society for Conservation Biology.

Case	Society for Conservation Biology (SCB)
What are the relevant nodes in governance meshwork explaining the impact of SPIORGs?	Target groups whose behavior the interest group is aiming to change; Legal and regulatory frameworks, which the interest group is aiming to change; Organizations and initiatives with similar agendas.
How do various nodes in governance meshwork and SPIORGs interact and explain impact?	Alliances with actors and organizations who may contribute to driving the mission (i.e. constructing ethno-epistemic assemblages to impact on governance meshwork); Interaction with target groups.
What pre-existing characteristics of SPIORG participants impact on the boundary negotiations and how?	Personal motivations of interest group members to change the world; SCB label may be used in a strategic way, involving political activism by individual members of the interest group; Personal networks that can be used to construct ethno-epistemic assemblages.
Pathways to impact	To use established scientific approaches, paradigms and knowledge to justify the mission for wide and diverse audiences; Making use of strategic partnerships with other organizations and initiatives; To maintain credibility that allows it to provide scientific advice whilst also strongly 'driving' the conservation mission. Such balance requires controlling the type of messages and interventions delivered by the interest group and its members.

Table 5
Illustration of key issues for policy processes integrating scientific input: Finnish NBSAPs.

Case	National Biodiversity Strategies and Action Plans in Finland
What are the relevant nodes in governance meshwork explaining the impact of SPIORGs?	Policy makers and interest groups from various sectors who can implement the NBSAPs in practice; Organizations giving and supporting the mandate for NBSAPs (e.g. CBD; EU; National Parliament); National legal and regulatory contexts.
How do various nodes in governance meshwork and SPIORGs interact and explain impact?	Links to organizations giving a mandate to NBSAP objectives and processes; Established internationally accepted biodiversity and ecosystem service 2020 targets provide uncontroversial ground for negotiations within NBSAP forums.
What pre-existing characteristics of SPIORG participants impact on the boundary negotiations and how?	The agendas, missions, interests, responsibilities and motivations that the participating policy-makers have for their home organizations seriously limit the scope of changes NBSAPs can induce.
Pathways to impact	Gaining high level mandates and establishing a multi-actor NBSAP platform, which works in continuous way with a long term scope helping to mainstream biodiversity issues across policy sectors; Using monitoring methods and practices (e.g. indicators) to measure the development towards the biodiversity and ecosystem service related targets to mitigate the possibility of economic interests to argue that the "biodiversity issue is already well considered", hindering implementation of NBSAP actions; Getting high level policy makers to participate in NBSAP forum.

organizations struggle to get substantial funding for interfacing, climate change research is more generously funded (Veríssimo et al., 2014). In addition, the share of interfacing funding as part of research projects is often minor compared to the funds allocated for research. To cope with the challenge to gain impact with scarce resources researchers may organize themselves. For example, European biodiversity researchers have established the European Platform for Biodiversity Research Strategy (EPBRS) to lobby for biodiversity issues in research policy institutions: based on this they are currently building a policy support mechanism on biodiversity and ecosystem services expertise[1] .

5.3. Other existing and preceding interfaces

Pre-existing SPIORGs are an important part of the governance

Table 6
Key nodes in the governance meshwork and their connections to SPIORGs.

Nodes in governance meshwork	Connecting factors between SPIORGs and governance meshwork nodes	Cases
Mandating organizations	- Practices to gain mandate; - Measures to maintain and make use of the mandate; - Representation of organization giving the mandate in the SPIORG. - Movement of mandate from one organization to another; - (Partial) determination of the scope of the SPIORG by the mandate giving organization.	NBSAPs; IPBES
Funding organizations	- Financial support. - Individual and organized lobbying for funding certain types of research. - (Partial) determination of the scope of the SPIORG by the organization allocating the resources.	All
Other current and preceding SPIORGs	- Example and practical lessons learned on how to interface more efficiently. - Utilization of previously established networks of actors and organizations.	All
Implementing organizations	- Coverage of stakeholder groups, policy domains or nation states that may implement SPIs objectives included in the SPIORG. - Political support by national environmental ministries; - Conflicting responsibilities within national Ministries between promoting economic interests or supporting SPIORGs agendas. - Level of policy makers from implementing organizations involved in the SPIORG.	All
Client organizations	- Client organizations have a power to define the content of "demand" from the SPIORG. - SPIORGs need to balance pure science and normative policy recommendations in their relationships to client organizations. - Transparency helps clients to understanding the SPIORG's positions from which the input is given. - Ownership of clients on SPIORGs agenda. - SPIORGs need to select the targeted client organizations.	All
Supporting individuals	- In kind support. - Social networks. - Knowledge synthesis and resources of individuals. - Individuals driving the SPIORG's agenda (e.g. via activism and ambassadorship). - Individuals functioning as translators between diverse knowledge systems and as champions attracting funding and facilitating impact.	All
Scientific approaches	- Degree of institutionalization, popularity and acceptance of certain approaches (e.g. Conservation biology; Ecosystem Services).	IPBES; SCB
Actors providing knowledge (not only scientists, but also other stakeholders)	- Type of knowledge flows from science, society and policy to SPIORG. - Practices of SPIORGs to collect and synthetize knowledge (e.g. are social and natural sciences equally represented; are knowledge systems other than peer-reviewed science accounted for?).	IPBES; INBO;
Laws and regulations	- International regulations may require implementing environmental policies, which gives political space for SPIORGs and may lead to establishing fit for purpose SPIORGs. - SPIORGs often aim to change laws and policy regulations to perform better against SPIORG objectives.	NBSAPs WFD SCB INBO
Opposing and conflicting stakeholders	- Competing fact claims may undermine impact of SPIORGs - Trust between SPIORG and participating stakeholders is important for knowledge utilization and two-way interactions - Conflicts between diverse participating stakeholders may lead to implementation gap.	Especially IPBES; SCB

meshwork that affects the practices of many current SPIORGs. The historical development of biodiversity assessments is apparent in the increasing structural connections and governmental mandates of successive biodiversity assessments. Neither the GBA (Global Biodiversity Assessment, Heywood, 1995) nor the MA (2005) were intergovernmental bodies yet both were linked to a series of international governmental treaties including the CBD. The limited impacts of these predecessor processes was one important driver for making IPBES explicitly an intergovernmental body, organized under the auspices of the UN (Leemans, 2008; Watson, 2005; Sarkki et al., 2014). Connections across time are also made by individuals who participate in different processes over many years. For example, the two co-chairs of the MA have also been elected as first (2013–2016) and second (since 2016) chairs of IPBES. Similarly, successive NBSAP processes in Finland have enhanced relationships between the NBSAP process facilitators and policy makers, providing pathway to impact across policy sectors. Research projects have contacts, and share personnel, with other on-going projects and generally build on previous ones, in some cases very directly. Thus, current interfaces are tightly linked to earlier activities and learning from previous interfaces possibilities to enhance impact in the governance meshwork.

5.4. Implementing organizations

Organizations that can implement SPIORGs' goals in practice are a key node in governance meshwork determining SPIORGs' impact. One common strategy for SPIORGs is to include the representatives of implementing organizations in the multi-directional communications and face-to face meetings facilitated by the SPIORGs. This is especially relevant for NBSAPs involving national policy makers, and IPBES engaging national focal points across the globe. Furthermore, research projects may establish advisory boards and plan for impact together with implementing organizations. State based SPIORGs often have established relationships with national implementing organizations. However, even where the policy representatives are participating in the SPIORG's activities, the SPIORGs often exercise little direct influence over the agendas and practices of implementing organizations, since the positions of policy makers are likely to be pre-determined, at least in the short term (see Sarkki et al., 2016). Changing these set positions requires a long process of iterative interactions within the meshwork, of which participation in any given SPIORG activity is only a small component.

5.5. Supporting individuals

The role of individual action, motivation, expertise, work and networks is important for all types of SPIORG. Individual actors may support SPIORGs in a variety of ways also outside SPIORGs, based on their personal characteristics. The SPIORG is sometimes invoked in these personal interactions. For example, in the SCB case, individuals used the SCB label to oppose new road construction in rural areas in Poland. This can create problems for the SPIORG as the individual is not under the control of the SPIORG. For example, SPIORGs aiming for neutral "honest brokerage" may lose some of their legitimacy and credibility if the individuals associated with the SPIORGs are known to have strong advocacy goals (Ginger, 2014). Thus, while SPIORGs can clearly benefit from individual enthusiasm and commitment, they may face challenges to control the ways in which individual activities influence the work and external perception of the SPIORG.

5.6. Client organizations

Organizations demanding certain kinds of inputs (e.g. knowledge; expertise; networks; policy support) from SPIORGs can be conceptualized as "clients" with influence over a SPIORG's work. Client organizations are relevant for all types of SPIORG. The SPIORGs face the challenge of tailoring the communication and interactions to meet the specific demand, which varies significantly across different SPIORGs, including demand by specific policy process (NBSAPs), expected inputs from curiosity-driven research (research projects), the need to justify a specific agenda (interest groups), satisfying knowledge demand of national sector-based instances (state organizations), and meeting policy demands in a multi-level world (IPBES). Too close a focus on client organizations can lead to a risk of bias if only stakeholders who are part of established networks or the "usual suspects" are included. For example, in the INBO case, established networks cover nature conservation related organizations, but economic interests are not perhaps equally covered. Thus, SPIORGs encounter challenges in simultaneously satisfying demands of policy and stakeholder groups, whose positions cannot be integrated under single policy proposals (Schut et al., 2013). Lack of balanced consideration of opposing views may produce "false" legitimacy where policy advice may appear objective, but in fact can include implicit values and assumptions (Ginger, 2014). However, representing only a few views may be relevant for example for interest groups to drive their mission of being relevant for represented stakeholders. Another option would be to communicate uncertainties and consequences of various policy options widely (Stirling, 2010) and being transparent about vested interests.

5.7. Scientific approaches

The degree of institutionalization and recognition of scientific approaches used by SPIORGs affect the scope of knowledge production and reception of the resulting advice by policy actors (Kovács and Pataki, 2016). In fact, using well-established scientific approaches and paradigms can help to achieve and maintain credibility (Girod et al., 2009). For example, that conservation biology is an established discipline (Meine et al., 2006) helps to maintain SCB's credibility even though it engages in advocacy by providing policy recommendations. On the other hand, use of the currently fashionable ecosystem services paradigm helps IPBES to provide policy inputs that are seen as relevant and effective by national and international policy makers.

5.8. Knowledge providers

All SPIORGs have important connections to knowledge providers (not only scientists, but also various other stakeholders). For example, in the context of IPBES indigenous and local knowledge need to be formally recognized, and social science needs to play a larger role in developing policy relevant knowledge (Turnhout et al., 2012; Larigauderie et al., 2016). The problem of missing social science and local expertise could be overcome by both informal and formal networks of knowledge (Görg et al., 2016) and by developing transdisciplinary approaches involving natural and social scientists as well as various stakeholders (Lang et al., 2012).

5.9. Laws and regulations

Laws and regulations provide an important context for SPIORGs because the legal regulation heavily influences the use and conservation of the environment. Even though laws are relevant for all types of SPIORGs, most obviously they relate to SPIORGs participating in ongoing national policy processes, such as the NBSAPs and WFD implementation. These two differ as WFD is implemented by a hard law approach by EU directives and NBSAPs are based on a soft law generated by the CBD's voluntary guidelines. This difference between hard and soft law may pose problems for effective implementation of biodiversity objectives (Harrop and Pritchard, 2011). However, we found that in the Finnish NBSAP processes based on soft law contributed

[1] See www.epbrs.org and www.eklipse-mechanism.eu.

significantly to designing new national laws taking biodiversity more into account. Therefore, the laws and regulations are essential part of governance meshwork where SPIORGs act, but also a context which the SPIORGs change together with other actors in governance meshwork.

5.10. Opposing and conflicting stakeholders

In relation to Intergovernmental Panel on Climate Change (IPCC) stakeholders opposing IPCC's agendas have become relevant for IPCC's ability to make policy impact. The climate change skeptics have produced their own competing knowledge and achieved considerable space in media. In the field of ecosystem services and biodiversity so strong competition on fact claims has not occurred, perhaps because it is not threatening economic interests as much as climate change mitigation can. However, it has been pointed out that the IPBES may not be able to provide neutral space for negotiations and generation of knowledge has been considered as too political (Hotes and Opgenoorth, 2014; Vohland and Nadim, 2015), like with the case of CBD's Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) (Koetz et al., 2008). The unresolved contradictions between SPIORG and its target groups undermines credibility of the SPIORG, erodes trust and decreases potential for impact. Furthermore, IPBES needs not only build trust towards itself, but also between conflicting stakeholders to facilitate implementation of knowledge in practice (see Arpin et al., 2016).

6. Conclusion

This paper has provided a structured approach to better understand how SPIORGs impact and are impacted by various nodes in a complex governance meshwork in environmental domain. As a consequence of analyzing SPIORGs as positioned in a complex governance meshwork, this paper has shown that SPIORGs are linked to governance contexts via multiple dynamic processes encompassing prior, current and anticipated interactions. This meshwork framing highlights that SPIORGs must deliberatively attend to governance context in order to better understand and anticipate possibilities for influencing knowledge production and decision making. This is important as all the SPIORGs we examined had aspirations not only to understand better the environmental issues, but to make an impact on policies and society for environmental sustainability. A task for future research is therefore to identify how to purposefully design SPIORGs to match the expertise, roles and capacities within SPIORGs with relevant governance contexts, so as to constructively blur the boundaries and to make sense and impact together within and beyond governance meshwork. In this way SPIORGs may co-evolve with the governance meshwork, to improve the governance of biodiversity and ecosystem services and thus make a lasting positive impact on environmental sustainability.

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Appendix A. Supplementary data

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